

MEMORANDUM FOR: Director, Office of Global Issues

FROM: Executive Assistant to the DDCI

Would you take a look at the attached and let us know if it has any merit.

Thanks,



Attachment

Date 17 October 1984

STAT

FORM 101 USE PREVIOUS EDITIONS

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Cambridge, Massachusetts 02139



DEPARTMENT OF EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES  
(617) 253-3381 Telex: 92 1473

24 July 1984

Mr. John Bross



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Dear John:

We wish to ask your advice on a special proposal "Determination of Earthquake Hazard at NATO Installations and Other Critical Sites in Turkey". This needs to be sponsored by a proper American source, most likely by the U.S. Department of Defense.

The attached letter proposal describes the project and the analysis approach. The map shows that many NATO installations are in active earthquake areas.

Two American universities (M.I.T. and Boston University) which have the personnel, facilities and access to data to carry out the project, along with the Middle East Technical University, Ankara, Turkey, which will provide the detailed earthquake engineering input, are and will be in full cooperation to carry out this crucial program within two years. The total cost of the project for two years is about \$380,000. Our Turkish counterparts will provide their own expenses for work in Turkey.

We would appreciate your suggestions and advice as to how to proceed.

Sincerely,

M. Nafi Toksoz  
Professor of Geophysics  
Director, Earth Resources Laboratory  
M.I.T.

Asim Yildiz  
Professor of Aerospace Mechanical Engineering  
and Research Professor of Physics,  
Boston University

## DETERMINATION OF EARTHQUAKE HAZARD AT CRITICAL SITES IN TURKEY

### INTRODUCTION

Seismically, Turkey is one of the most active countries in the world. All parts of the country are subject to earthquake hazards to some extent. On the average, a damaging earthquake occurs somewhere in Turkey once a year. Since 1975 three significant earthquakes (Lice, Van, Erzurum) caused large scale damage and casualties in Eastern Turkey. Had these earthquakes occurred in Western Turkey, where there is both higher population density and more concentrated industry, the damage would have been far greater.

Earthquakes are a major problem for critical facilities, lifelines and military installations. Figure 1 shows a distribution of earthquake epicenters, active faults and locations of some NATO installations in Turkey. To the best of our knowledge, in depth earthquake hazard analyses have not been made for these installations. The available seismic zoning map divides the country into four zones - 1st, 2nd, 3rd and 4th degree - where 1st is the most dangerous and 4th the least. All four major quakes since 1975 occurred in 2nd degree zones. Military as well as other government installations suffered extensive damage in these earthquakes.

### PROPOSED STUDY

In this study we propose to undertake a quantitative assessment of earthquake hazard at 10 specific sites where there are major NATO installations and other critical facilities. The result of these calculations will be the peak ground motion that can be expected at these sites in a given time period such as one year or ten years.

The calculation of earthquake hazard at a given site requires the frequency and magnitude of potential earthquakes in that general vicinity, of models of ground motion attenuation, and a computational approach to combine effects of all possible earthquakes.

In the past few years, several major pieces of data have become available and new probabilistic risk assessment methods have become available. These include:

- (1) Earthquake epicenter data have improved because of an expanded seismic network in Turkey.
- (2) More detailed mapping of active faults has been achieved using data from space (Landsat) and SIR-A (radar imagery) as well as ground mapping. The active faults are far more numerous than those shown on available geological maps.
- (3) A number of strong motion instruments have recorded seismic ground motions near the earthquakes. Very high accelerations have been measured in the near field of some moderate earthquakes (0.5g for earthquakes of magnitude 5.1).
- (4) New Probabilistic Hazard Analysis (PRA) techniques have been developed in the U.S. for assessment of earthquake hazard at nuclear power plants and other critical sites.

In this study we will prepare a general seismotectonic zoning for the country, especially detailed seismic source zones around the facilities. In this study we will further establish an earthquake data base for Turkey and surrounding areas (including the Aegean, N.W. Iran and the Caucasus), both for instrumental and historic data. Combining these with geologic data we will prepare a seismotectonic zoning around critical facilities. Finally, using attenuation models tested with recent earthquake data we will carry out the

probabilistic earthquake hazard curves for each site. This methodology is being used to determine the earthquake hazard at critical sites (nuclear power plants, dams) in the United States.

The work will be done with the collaboration of three scientists: M.N. Toksöz (MIT, a seismologist), A. Yildiz (Boston University, Applied Mechanics and Physics), and M. Erdik (Middle East Technical University, Ankara - earthquake engineer). Professors Toksöz and Yildiz have active scientific studies (including seismic hazards and tectonics) and collaboration in Turkey. Professor Erdik received his Ph.D. at Rice University and is the Director of Earthquake Engineering Research at Middle East Technical University, Ankara, Turkey.

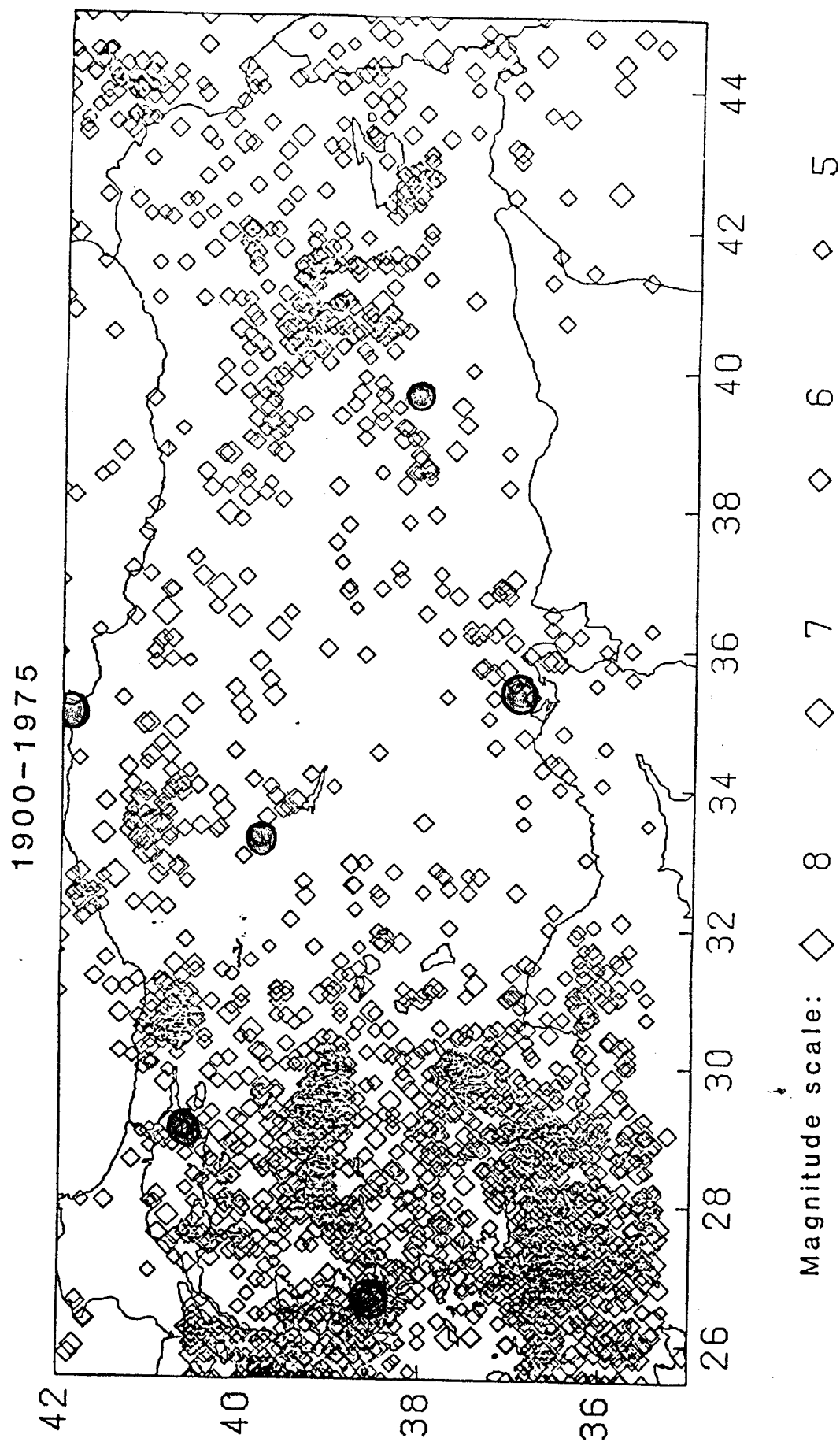


Figure 1a. Distributions of earthquake epicenters in Turkey and surrounding areas for the period 1900-1975.

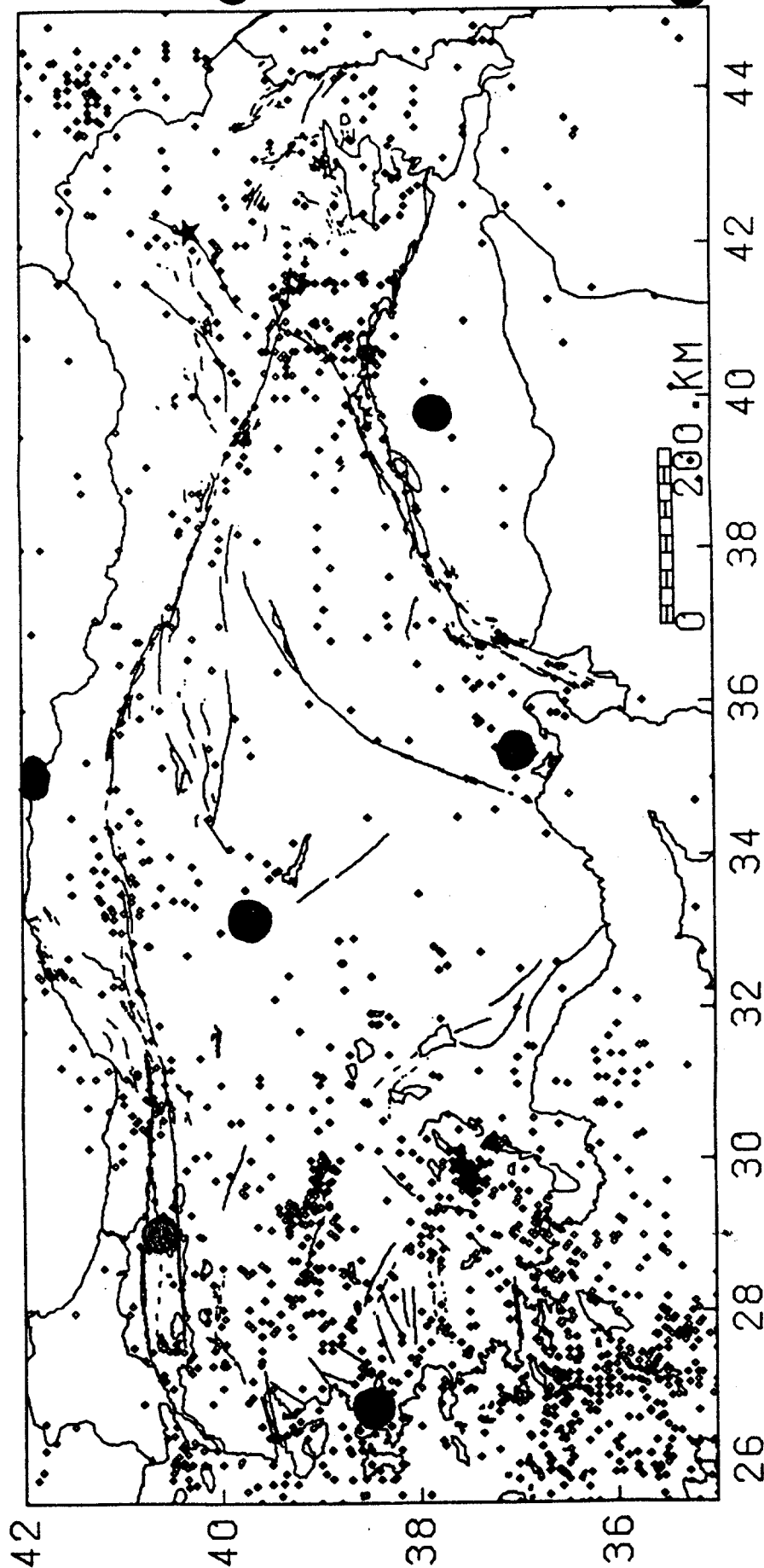


Figure 1b. Active earthquake faults and major earthquakes (1900-1975) in Turkey.

NATO installations are shown as circles.